anhydride, and to increase the secondary phosphates to the extent of 40 per cent. of the total existing in original grain.

It is unnecessary to extend such considerations further, and my chief desire has been to demonstrate that, in view of the ratio of salts to mineral matter in the mash tun itself when supplies are uniformly hardened, they, in all probability, exercise no important effect on conversion products. That the salts do, however, in the copper when the ratio is modified definitely influence the results. That the action of earthy carbonates, in increasing the di-alkali phosphates, justifies their more complete separation.

That a correct ratio of neutral calcium salts to salts of magnesia is necessary to the most perfect precipitation of secondary phosphates.

That under usual conditions 45 grains per gallon of the neutral lime salts would suffice, and of this some 50 per cent., being precipitated, would exercise no influence on wort gravities.

I fully recognise that much further work is necessary to establish the effect of sulphates versus chlorides on yeast nutrition, the practical absence of potassium from Burton beers and the presence in quantity in products brewed with water relatively rich in chlorides bearing upon this subject.

Present Standards of Malt Selection and Control.

By William Duncan, F.I.C.

Accuracy in the selection and control of malt supplies is essential to any permanent success, and although different quality standards are necessarily influenced by many factors, yet a great amount of judgment and experience is requisite in fixing the standard for analysis, as also the types of grain to be favoured according to seasons.

Malt extract remains the chief constituent of collected worts, and on it the brewer depends for the success of his fermentations. It is therefore natural that much thought and research should have centred upon defining the characteristics of malted grain, with a view to establishing standards for control of deliveries.

The brewing industry, however, stands in a somewhat exceptional position, and at times seems to have been unduly exacting in demands in the standard adopted, for of necessity the quality of barley must vary between wide limits from season to season, and even as drawn from localised areas, so that insistence on delivery to comply with rigid standards is liable to become arbitrary and has not always resulted in grain being worked to the best advantage.

The maltster contracting for the supply of any large proportion of grain must perforce draw from comparatively wide areas barley—it may be of a defined type, but none the less differing in important points as to comportment on the malt-house floors, and of necessity in the values yielded by the malts when submitted to analysis. A direct sequence to the adoption of standards has naturally been a careful blending of different strippings defined by the values fixed by any particular firm, so that the mixture may give mean values complying with such standards.

This may or may not have proved an advantage, although much is to be said for the merits of mixed grists. The frequent criticisms appearing in the Journal indicate possible weaknesses in present methods of malt examination.

Dr. E. R. Moritz was one of the pioneers in initiating critical standards of control with a view to checking malting methods, and the work resulting has exercised a marked influence on malt-house routine. The standards adopted, even at times arbitrary, have concentrated attention on grain characteristics, and the gradual more stringent adherence to Malt Analysis Committee methods should moderate the recriminating comments.

This subject resolves itself into the issues as to how far methods of malt evaluation are effective as a—

Control of malt-house work to firms making up their own grain ;
and
Selection and control of outside deliveries.

The most usually practised tests include of course : Extract, moisture, colour, diastase, and cold extractives.

If the tests are conducted consistently by the fixed methods a reasonable uniformity should be ensured, the interpretation and application of the results being of greater importance.

Analytical values are fortunately becoming recognised as of little use without considerable knowledge as to characteristics of different grades of barley, and that without such most misleading deductions are inevitable. Figures in the absence of this information and detailed physical tests are of little account, and even to-day one would hesitate to predict the effect of introducing a particular malt on fermentations and beer soundness; for the knowledge at command as to nitrogenous and phosphatic constituents in this reference is but meagre and inexact. It is a matter for little surprise that the success of any firm turns upon wide experience and good judgment in respect to the barley selection from season to season, and type of market malt favoured. Failure to correlate analytical results and character of malt to barley has in the past checked progress, for in fixing values we have to recognise the same are only possible in relation to grain steeped, and it marks a real advance, that increased attention is now being given to barley and its critical examination.

It is not unusual, none the less, to have contracts suggested, such as diastatic power of 25 not to exceed 30 for mild ale malt, and cold-water extract of 18 to 19 per cent., and yet a class of grain is selected, controlled by market quotations, which the trained maltster knows well could not possibly be successfully malted to comply with such a request. Or, again, a malt is favoured for use with a fairly large quantity of raw grain because the diastatic power is 40 or some similar figure, whereas malt of different type and of considerably lower diastatic power would have decided preferable conversion.

If the best results are to accrue from the application of laboratory tests as a control of malting routine, it is essential that the chemist should have before him the maximum information, and, in particular, the average of the barley wetted. Given such details, the subsequent laboratory examination can play a most important function, and an opinion has to be formed as to: degree of modification; the probable method by which the modification was decided; the curing treatment, with special reference to suitability for beer intended.

Recognising the importance of a fall in extract returns any such result merits close examination, and would decide the careful physical inspection of the sample followed by a review of working methods. If followed through with the foreman maltster my experience has been that an alteration in the treatment of a future wetting is capable of effecting improvement, and in fully appreciating the influence of climatic conditions and the necessitated use of mixed barleys, believe that with greater faith in the possible accuracy of extract estimates, their modification justifies more attention than they at times receive.

The more difficult and important problem is defining the extent to which the laboratory tests are competent to check the methods adopted in arriving at any particular degree of modification. The query indeed resolves itself into the simple issue as to "forcing" or "non-forcing" treatment. It is unnecessary to discuss what constitutes forcing and non-forcing on the floor or kiln, but I should like to elicit information as to actual experiences with forced grain, since, although supporting the view that forced malt is undesirable, I have no well-defined views as to the manner in which such grain influences results, and the ferment in particular, and do not consider any explanation on a carbohydrate basis suffices.

The most usual effect of the treatment is to raise the proportion of non-coagulable nitrogenous constituents existing in assimilable form, but not to a greater extent than might result from a Continental extraction system, or even the substitution of foreign grain of recognised merit; and here a real problem awaiting solution exists, for the condemnation of forced grain has not yet to my knowledge been confirmed by other than practical brewing results, and one knows well the many varied influences liable to mask the issue.

Admitting the defects of forced material, analytical tests become the chief agent in detection. With the limited knowledge as to the manner in which the nitrogenous and other constituents of grain in forced malt react upon yeast, one is reluctant to express the opinion that the standards fixed have been at times unfair and have necessitated a more heavy use of foreign grain or a yeast nutrient for corrective purposes, but I believe that some of the defects of the earlier pneumatic malt, worked by an unusually slow, cool, and extended germination process, might be traced to the insufficient simplification of nitrogenous constituents, with consequent sluggish fermentations and high finals as frequent experiences.

Admitting forcing to be detrimental, can laboratory tests detect with certainty this defect? If accepting the principle that the malting operations should determine the maximum extract with limited formation of cold extractives and diastatic power, then the issue becomes comparatively well defined, and analytical values of much use. The customary standards of detecting forcing need not be referred to in any detail, resolving themselves into a comparison of the ratio existing between colour, diastatic power, and soluble products; colour being accepted as the broad index of the severity of the kiln treatment, and of two malts made from similar barley the grain indicating the more normal ratio would have preference, but, as previously intimated, broad discrimination is necessary as to what constitutes a normal ratio for any particular type of grain.

From the contradictory results recorded in reference to the relationship existing between diastatic power and the eventual composition of mash worts, the brewer's faith must have been shaken as to the importance attaching to the former estimation, for it has been often proved that grain of high diastatic power under similar conditions of treatment yields less sugar than malt of lower diastatic power. This is undoubtedly due in great measure to difference in the condition of starchy matter, but in addition the fact that many barleys possess a higher diastatic power than finished malts may have a bearing on the irregularity, for such diastase must influence the reading for the finished malt when making the test with soluble starch. The soaking of barley for very extended periods fails at least to secure the extraction of the diastatic principles, so that with any two malts the Lintner value may be due in part to barley diastase, as also to germination diastase, assuming however that the former is not the nucleus of malt diastase. The suggestion made by Matthews and Lott that diastatic power might with advantage be made on gelatinised starch bears upon the question. Barley extract under this test fails to give any indication of importance but with certain types of barley, and frequently a value of 25 to 30 would not be unusual with soluble starch, whereas with malt extract but slight differences are noted in the results of the test made by the two methods. This is, as you know, explained by the absence of any appreciable starch-liquefying action of the barley extract.

The fact is well illustrated by selecting a barley of 25 Lintner and a malt of similar value

B 25	M 31
B 7	M 28

If the Lintner test be made on the mixture of 50 per cent. barley and 50 per cent. malt with soluble starch the resultant was 26 Lintner. The Lintner test therefore fails to indicate the influence of unmodified grain to any reasonable extent, and this weakness, in conjunction with the fact that barley diastase is differently influenced by conversion temperatures to germination diastase, may have some bearing upon the reported discrepancies referred to as to the nature of wort constituents relative to diastatic power.

It might be argued that as a sufficiency of liquefying diastase always exists in the brewer's mash tun this is of minor importance, but with equal force the contention would be justified in respect to saccharifying diastase, and greater attention to the liquefying capacity of grain, as influenced by malting conditions and barley steeped, seems to merit reference.

Tests made do, at any rate, demonstrate that the relationship between liquefying and saccharifying action is by no means regular, and that malts working most readily in the tun, in respect to rates of yielding extract, are such as exhibit the liquefying capacity to the greatest extent.

Type of malt.	Colour of wort. Lovibond ½-in. cell.	Diastatic activity, Lintner.	Relative liquefying capacity.	Extract per quarter.
Ouchac, mixed	4·0 units	58	44	84·4
English, mellow Yorkshire ...	4·5 „	31	100	97·9
„ light Chevallier	4·0 „	42	50	90·8

Notwithstanding the attacks made upon the diastase determination, the estimation is capable of serving a most useful part, both in gauging curing and the detection of forcing, for, the liquefying capacity being but slightly affected by the kilning process, any such estimate would form no useful index.

As to cold extractives, which have so frequently been discussed by this and other sections, a much broader basis of judging is now usual, and after the indications of Dr. Horace Brown that during kilning soluble carbohydrates frequently increased without any increment in the permanently soluble nitrogenous matter, the latter estimate is not usually made, although previously considered of importance in detecting "forcing."

With the limited time at disposal I have elected to refer at this stage to some fermentation problems, for these are naturally intimately related to grain quality.

In my previous remarks stress has been laid upon the importance of barley as defining analytical values and the necessity for fixing a standard by different firms sufficiently high to meet trading conditions. The standard adopted for laboratory tests becomes of great utility in control of malted grain, and any abnormal values, in particular the ratio of colour to diastase, interpreted in conjunction with flavour as the most reliable indication of "forcing."

Extract from Mr. Chapman's remarks on the discussion following Mr. Briant's paper, read before the Brewing Institute (London) in 1907 (this Journal, **13**, pp. 144, 145):—

"A considerable amount of attention had been devoted to the study of yeast nutrition, and much work had been done, more especially during recent years, to ascertain what substances were favourable to the vigour of the yeast organism and to healthy fermentation, but, as far as he was aware, very little attention had been devoted to the study of those substances which exerted an injurious or inhibitory effect on the yeast organism. There were certain nitrogenous bodies formed as the result of extreme proteolytic activity, which were known in one or two cases, at least, to exert, even in very small quantities, a poisonous action on yeast. He referred to such substances as choline, betaine, and argenine, which were present in malt wort and which could be even detected in beer."

And, further:—

"Many brewers were, as was well known, in the habit of adopting a system of mashing known as the digestive system, in which an endeavour was made to secure the maximum amount of proteolytic change in the mash-tun, so as to produce the highest proportion of yeast-feeding albuminoids."

The result of this treatment in increasing the proportion of assimilable nitrogenous matter existing in the finished beers does not account sufficiently for the fermentation irregularities experienced from their use, and might refer to the weighty expression of opinion of Mr. Chapman in 1907.

The very general adoption of rousing methods with a view to stimulating reproduction tends to mask the effect of wort constituents on yeast, but it is conceivable that this forcing action may decide the transference to worts of objectionable products.

Investigations have to the present time primarily considered the influence of the assimilable nitrogenous matter in respect to quantity, and the importance of reducing the amount residual in the beers has resulted in much more advanced aëration than was formerly adopted.

Reproduction within close limits agrees with nitrogen removal, but any modification on yeast vitality and the character of the fermentation products has become less apparent, and at times the stability of produce appears to have been affected.

It is known that the more fully simplified the nitrogenous constituents of wort the smaller the reproduction of yeast under limited aëration conditions for any given attenuation, but if stimulating yeast reproduction in such extract by aëration the possibility of influencing the ferment in a retrograde direction exists.

Some of the conflicting views as to the use of new malt and the diverse opinions expressed are explicable by modified aëration conditions, and as analytical tests fail to discriminate between new and mature malt it may be that in the discussion some useful inferences may be drawn as to the observed effect of new and old malt on fermentation.

Practical observations do at any rate support the view that, unless definite aëration is resorted to, the use of new malt exercises a detrimental effect upon fermentation, and even when corrective aëration treatment is adopted the ferment undergoes more marked modification than follows the introduction of more fully matured grain.

A further example may suffice to indicate the defects of present methods of malt valuation relative to the probable influence of grain on fermentation.

The malt in question had been made up from medium grade Chevallier barley, and although not germinated with any uniformity passed laboratory tests as in every respect of average merit, but the effects of introducing the grain into the grists four weeks from stripping was to decide an abnormally rapid attenuation rate, although the examination of mash worts failed to indicate any unusual proportion of fermentable sugars.

The experience was the more noteworthy from the fact that the yeast in use was one normally dependent upon intermittent rousing.

Attempts to check the action of the malt by more early aëration, change yeast, and altered mashing system proved futile, but, contradictory as it may appear, the corrective represented the use of a yeast nutrient containing large proportions of fully simplified nitrogenous constituents, an effect apparently in opposition to theoretical indications.

It may well be that in many breweries the fermentations throughout the year exhibit but minimal irregularities, but these fortunate experiences are primarily ensured by accuracy of decision in respect to barley purchased, and present methods of analysis should be recognised as only competent to control the treatment to which the barley has been submitted.

In other words, to whatever extent a malt for mild ale brewing may be desired having a diastatic power of 25 it must be the barley selected which controls the issue, but in accepting any particular class of grain then the recognised analytical and more important physical tests become valuable in controlling the quality of consignments, both in reference to barley steeped and its treatment.

Hot Aëration.

By WILLIAM DUNCAN, F.I.C.

THE influence of hot aëration on wort constituents merits greater attention than is generally given, and I may, perhaps, express the opinion that increased attention to the hot aëration of worts has on several occasions proved effective in improving fermentations, and in moderating fining difficulties.

The influence of hot wort aëration on wort constituents was so well explained by Pasteur that one hesitates to remind you of some of the deductions, but having proved the issues so frequently ignored, in the prominence given to other objectives, a reference to the results may best serve as introduction.

With deep receiving vessels as substitutes for coolers the necessity for aëration naturally is increased, and although much may be done by the wort spraying arrangements to cooler, more effective working represents the adoption of a system of hop-back circulation of worts,